SECONDARY SCHOOL IMPROVEMENT

PROGRAMME 2021

2021

GAUTENG PROVINCE
EDUCATION
REPUBLIC OF SOUTH AFRICA

GRADE 12

SUBJECT: PHYSICAL SCIENCE

LEARNER GUIDE

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SESSION NO: 1

TOPIC: MOMENTUM AND IMPULSE

Momentum and Impulse [EXAMINATION GUIDELINES]

Momentum

- Define *momentum* as the product of an object's mass and its velocity.
- Describe the *linear momentum* of an object as a vector quantity with the same direction as the velocity of the object.
- Calculate the momentum of a moving object using p = mv.
- Describe the *vector nature of momentum* and illustrate it with some simple examples.
- Draw vector diagrams to illustrate the relationship between the initial momentum, the final momentum and the change in momentum for each of the above examples.

Newton's second law of motion in terms of momentum

- State Newton's second law of motion in terms of momentum: The resultant/net force acting on an object is equal to the rate of change of momentum of the object in the direction of the resultant/net force.
- Express Newton's second law of motion in symbols: $F_{net} = \frac{\Delta p}{\Delta t}$
- Calculate the change in momentum when a resultant/net force acts on an object and its velocity:
  - Increases in the direction of motion, e.g. 2nd stage rocket engine fires
  - Decreases, e.g. brakes are applied
  - Reverses its direction of motion, e.g. a soccer ball kicked back in the direction it came from

Impulse

- Define *impulse* as the product of the resultant/net force acting on an object and the time the resultant/net force acts on the object.
- Deduce the impulse-momentum theorem: $F_{net}\Delta t = m\Delta v$.

- **Use the impulse-momentum theorem to calculate the force exerted, the time for which the force is applied and the change in momentum for a variety of situations involving the motion of an object in one dimension.**
- **Explain how the concept of impulse applies to safety considerations in everyday life, e.g. airbags, seatbelts and arrestor beds.**

Conservation of momentum and elastic and inelastic collisions

- **Explain what is meant by *a closed/an isolated system* (in Physics), i.e. a system on which the resultant/net external force is zero.**
- **A closed/an isolated system exclude external forces that originate outside the colliding bodies, e.g. friction. Only internal forces, e.g. contact forces between the colliding objects, are considered.**
- **State the principle of conservation of linear momentum: The total linear momentum of a closed system remains constant (is conserved).**
- **Apply the conservation of momentum to the collision of two objects moving in one dimension (along a straight line) with the aid of an appropriate sign convention.**
- **Distinguish between *elastic collisions* and *inelastic collisions* by calculation.**

LEARNING OBJECTIVES

The following concepts are very important. You must be able to ***define*** each of the following:

Momentum

Change in momentum

Impulse

Net force

Isolated system

- ***State*** the following :

Principle of conservation of momentum.

Newton's second law in terms of Momentum

- Explain the relationship between the net force and the change in Momentum for a variety of motions.
- Express the principle of conservation of momentum as an equation in all situations, explosion or collision using $\sum p_i = \sum p_f$
- Draw vector diagrams to illustrate the relationship between the initial momentum, final momentum and the change in Momentum
- Do calculations on:

  - Momentum of a moving object using $p = mv$.
  - Change in momentum using $\Delta p = m\Delta v$.
  - All types of collisions (Elastic and inelastic collisions) using the following equations:
    - $m_1 v_{i1} + m_2 v_{i2} = m_1 v_{f1} + m_2 v_{f2}$
    - $m_1 v_{i1} + m_2 v_{i2} = (m_1 + m_2) v_f$
    - $(m_1 + m_2) v_{fi} = m_1 v_{f1} + m_2 v_{f2}$
  - Impulse using $F_{net}\Delta t = \Delta p = m(v_f - v_i)$
  - Proving that collisions are elastic or inelastic by comparing the total kinetic energy of the system before and after collision by using:

    $\frac{1}{2}mvi^2 + \frac{1}{2}mvi^2 \; for \; the \; two \; objects$

    $\frac{1}{2}mvf^2 + \frac{1}{2}mvf^2 \; for \; the \; two \; objects$

    If the energies are the same then the collision is elastic BUT if not then the collision is inelastic

- Solve impulse problems based on a graph.

MOMENTUM AND IMPULSE PROBLEM SOLVING STRATEGY

1 Read the problem as many time as you need, draw a sketch or diagram of the situation described if not provided.

2 From the reading collect the data and write it in symbolic form (not only numbers are part of the data

3 Draw a free body diagram for each object and clearly define the system you are going to work with.

- If possible, choose a system which is isolated ($\vec{F}_{net} = \vec{0}$) and closed (m=constant). If the interactions are sufficiently short and intense you can ignore external forces.
- If it is not possible to choose an isolated system, try to divide the problem into parts (SCENARIOS).

4 Select the law (principle), theorem, equation or formula that will answer your question.

- If the mathematical representation is based in the law of conservation of momentum $\left(\sum \vec{p}_{initial} = \sum \vec{p}_{final}\right)$. Write it in component form.

5 Substitute the values into the equation or formula (the system of units must be homogeneous)

6 Check your answer

- Is the unit correct?
- Is the value of the answer reasonable?

: Check that your result has the correct units, is reasonable and answers the question.

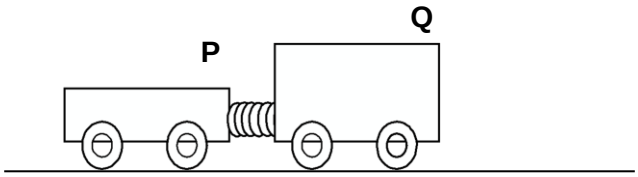
ACTIVITIES ON LINEAR MOMENTUM AND IMPULSE:

MULTIPLE CHOICE QUESTIONS

1.1 The net force acting on an object is directly proportional to the ...

A. mass of the object
B. acceleration of the object
C. change in momentum of the object
D. rate of change in momentum of the object

1.2 Two trolleys, **P** and **Q**, of mass *m* and 2*m* respectively are at rest on a frictionless horizontal surface. The trolleys have a compressed spring between them.



The spring is released and the trolleys move apart. Which ONE of the following statements is TRUE?

A **P** and **Q** have equal kinetic energies.

B The speed of **P** is less than the speed of **Q**.

C The sum of the final kinetic energies of **P** and **Q** is zero.

D The sum of the final momentum of **P** and **Q** is zero.

1.3 Net force is a measure of the …

A change in energy.

B rate of change in energy.
C change in momentum.
D rate of change in momentum

1.4 A vehicle with mass *m* is moving horizontally at a constant velocity on a frictionless path. The kinetic energy of the vehicle is *K* and the momentum is ***p***.

The velocity of the vehicle can be given as:

A. $\frac{K}{2p}$

B. $\frac{2K}{p}$

C. $\frac{K}{p}$

D. $\frac{p}{K}$

1.5 When an airbag inflates in a car during a collision, the chances of serious injury to a passenger is reduced because the

A passenger is brought to rest in a shorter period of time

B net force acting on the passenger is reduced.

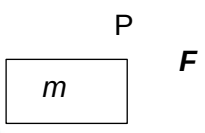
C passenger's change in momentum is reduced.

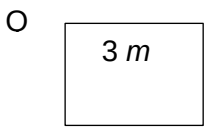
D passenger's change in momentum is increased.

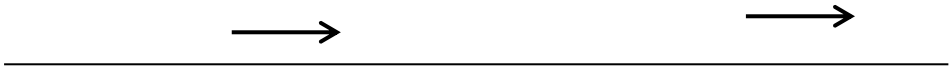
1.6 The impulse acting on an object is equal to the …..

A. product of the mass and velocity of the object.
B. acceleration of the object.
C. change in momentum of the object.
D. rate of change in momentum of the object.

1.7 A net force ***F*** acts on each of two isolated objects, P and Q, shown below. The mass of Q is three times that of P. (Ignore the effects of friction).







If the rate of change of momentum of object Q is x, then **the rate of change of momentum** of object P is as follows :

A. ⅓ x
B. ½ x
C. x
D. 3 x

1.8 A spacecraft of mass *M i*s moving in free space with a velocity ***v*** when it explodes and breaks into two parts. After the explosion, a portion of the spacecraft with mass *m* is left stationary.

Which ONE of the expressions below gives the velocity of the portion that is motion?

A. $\frac{Mv}{M+m}$

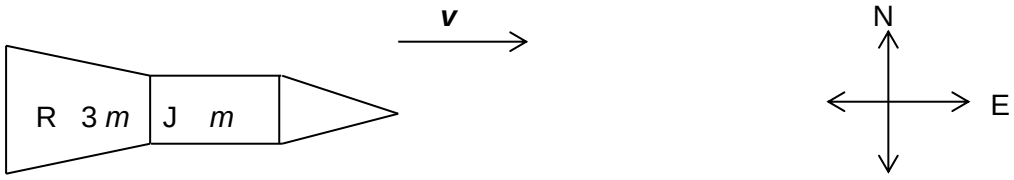
B. $\frac{Mv}{M-m}$

C. $\frac{(M+m)v}{M}$

D. $\frac{Mv}{m}$

1.9 A spacecraft, made up of two modules R and J of masses **3** *m* and *m* respectively, is travelling horizontally at a velocity ***v*** due east.

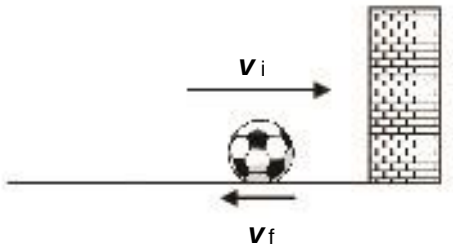
An explosion causes the two modules to separate.



Module J continues in its original direction immediately after the explosion with a velocity of 3 **v**. What will be the **magnitude and direction** of module R's velocity immediately after the explosion?

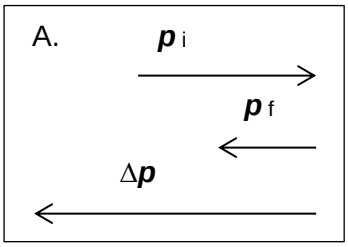
	Magnitude of velocity of R	**Direction of R after explosion**
A	1 ***v***	East
B	1 ***v***	West
C	⅓ ***v***	East
D	⅓ ***v***	West

1.10 A ball, mass m, moves towards a wall, collides inelastically with the wall and moves back.

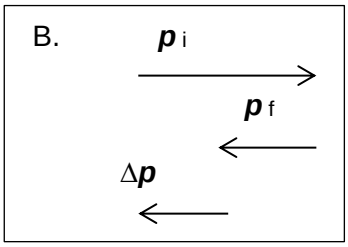


Which one of the following vector diagrams shows the correct relationship between the initial momentum (p_i) of the ball, the final momentum (p_f) of the ball and the change in momentum (Δp) the ball experiences?

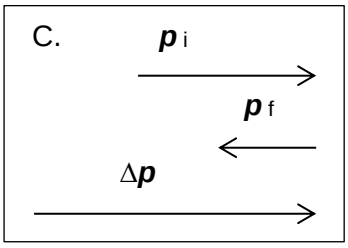
A.



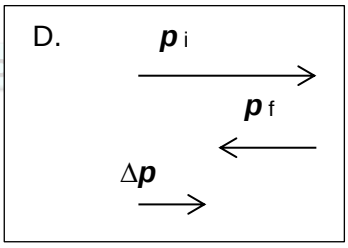
B.



C.



D.



1.11 A tennis ball of mass ***m***, hits the wall perpendicularly at a speed of ***v***. The ball rebounds from the wall at a speed of ½ ***v***. The magnitude of the impulse of the wall on the ball is …

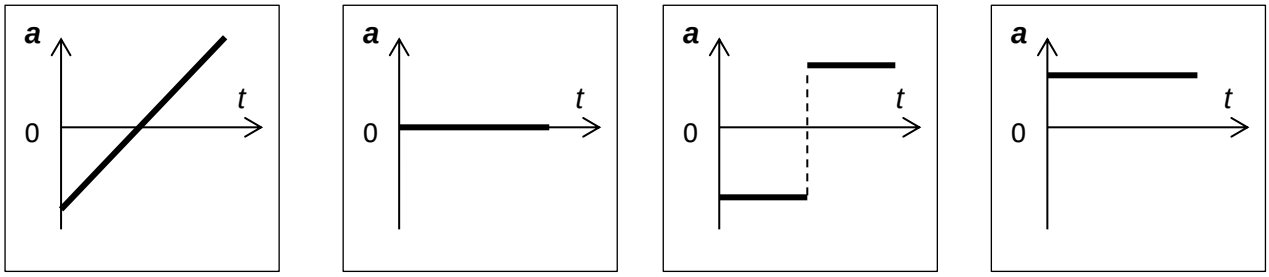
A $1\frac{1}{2}\,m\,v$

B $m\,v$

C $\frac{1}{2}\,v$

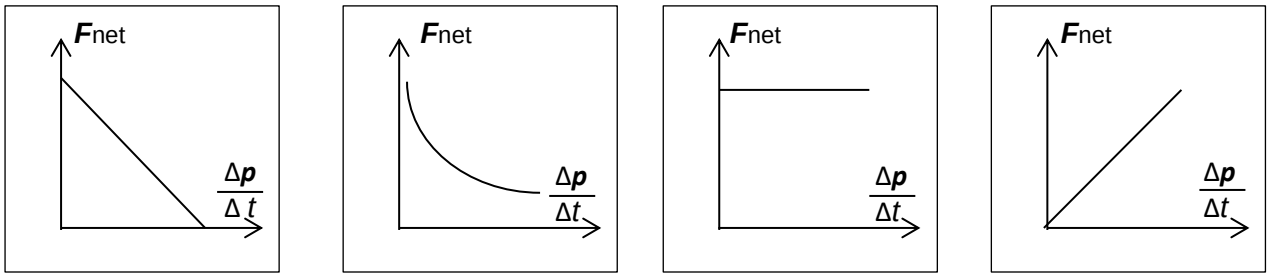
D $2\,m\,v$

1.12 An object has a momentum ***p*** for a time of *t* seconds. Which ONE of the following graphs correctly shows the acceleration-time relationship for this time interval?



A B C D

1.13 When a constant net force acts on an object, the object moves but its mass remains constant. Which one of the following graphs represents the relationship between the net force, F_{net}, acting on the object and the rate of change in its momentum? Ignore friction.



A B C D

1.14 A ball of mass ***m*** travelling west at a velocity ***2 v*** strikes a wall. After striking the wall it travels east at a velocity ***v***. The change in momentum of the ball is

A *m* ***v*** west

B *2 m* ***v*** west

C *2 m* ***v*** east

D *3 m* ***v*** east

STRUCTURED QUESTIONS

QUESTION 2

2.1 Two boys, each of mass **m**, are standing at the back of a flatbed trolley of mass 4**m**. The trolley is at rest on a frictionless horizontal surface.
The boys jump off simultaneously at one end of the trolley with a horizontal velocity of 2 m·s^{-1}. The trolley moves in the opposite direction.

2.1.1 Write down the ***principle of conservation of linear momentum*** in words. (2)

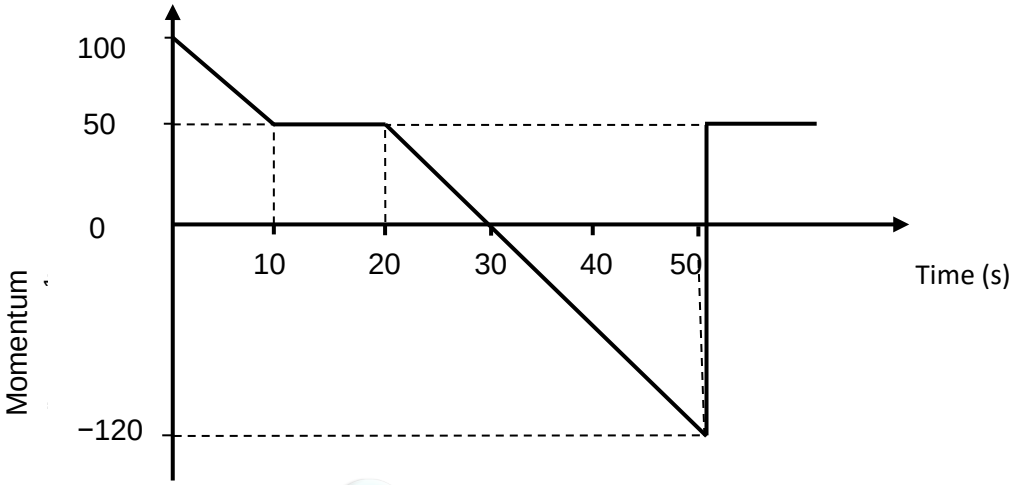
2.1.2 Calculate the final velocity of the trolley. (5)
(1 m·s^{-1})

2.1.3 The two boys jump off the trolley one at a time. How will the velocity of the trolley compare to that calculated in QUESTION 2.1.2?
Write down only GREATER THAN, SMALLER THAN or EQUAL TO. (1)

[8]

QUESTION 3

The momentum versus time graph of object **A**, originally moving horizontally EAST, is shown:



3.1 Write down the definition of *momentum* in words. (2)

3.2 The net force acting on object **A** is zero between t = 10 s and t = 20 s.
Use the graph and a relevant equation to explain why this statement is TRUE.
(2)

3.3 Calculate the magnitude of the impulse that object **A** experiences between t = 20 s and t = 50 s. (3)

(***170 N·s***)

3.4 At t = 50 s, object **A** collides with another object, **B**, which has a momentum of 70 kg·m·s^{-1} EAST.

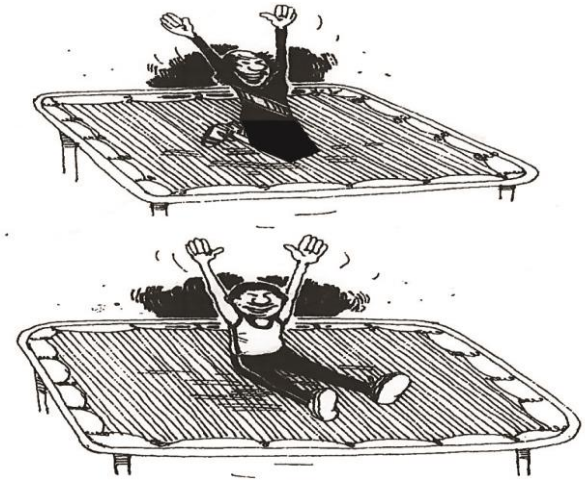
Use the information from the graph and the relevant principle to calculate the momentum of object **B** after the collision. (5)

(***100 kg•m•s^{-1} west***)

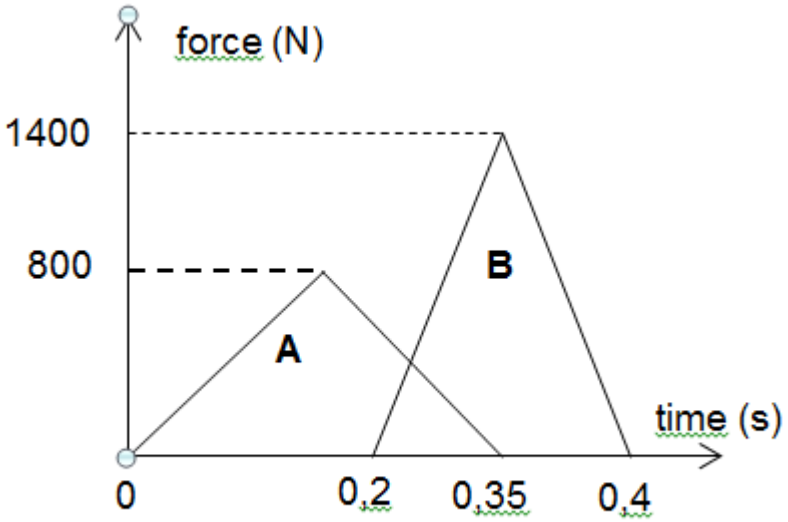
[12]

QUESTION 4

The pictures below show a girl of mass 45 kg and boy of mass 65 kg, bouncing off separate, identical trampolines at a fun fair.



The graphs below show how the forces exerted by the trampolines on the children vary with time during one bounce. Graph A represents the force exerted on the girl by the trampoline and Graph B represents the force exerted on the boy by the trampoline.



4.1 Define IMPULSE. (2)

4.2 Show with the aid of relevant calculations that the impulse of the boy is equal in magnitude to the impulse of the girl. (5)

4.3 If the boy and girl jumped onto their trampolines from the same height, which ONE of the two will rebound with a greater speed? (1)

[8]

QUESTION 5

.A boy on roller blades with his hands on a fully loaded trolley, mass 18 kg, moves west at 5 $m \cdot s^{-1}$ over a frictionless surface as shown in the sketch. The boy now pushes the trolley so that he moves at 1 $m \cdot s^{-1}$ east after this push. The mass of the boy and his roller blades is 45 kg.

5.1 State the conservation principle that is applicable during the interaction between the boy and the trolley. (2)

5.2 Calculate the velocity of the trolley directly after the boy pushed it. (4)

20 m·s^{-1} west

5.3 During the pushing motion of the boy on the trolley, the trolley experiences impulse. How does the magnitude of the impulse that the boy experiences compare to that of the trolley? Write down INCREASES, DECREASES or REMAINS THE SAME and explain your answer. (4)

5.4 If the force exerted on the trolley lasts 0,4 s, calculate the force that the boy exerts on the trolley. (4)

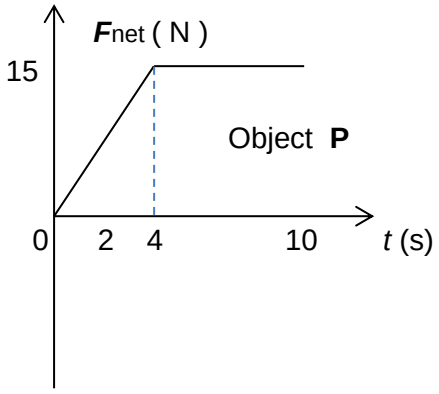
675 N west

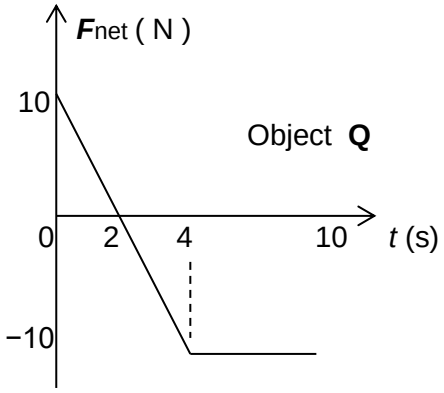
5.5 A girl of mass 40 kg is given a lift on the back of a 10 kg bicycle by a boy of mass 30 kg.They travel at a constant speed of 2,5 $m \cdot s^{-1}$.The girl wishes to get off the back of the bicycle while it is still moving.
She knows that if she just puts her feet on the ground and stands up, she is likely to fall over. Use the law in physics to explain why she falls over. (2)

[16]

QUESTION 6

The following graphs show the net force experienced by each object respectively during the same time interval.





6.1 Calculate the total impulse experienced by object **Q** in 10 s (3)

60 N•s in the opposite direction, west.

6.2 Compare without using any calculations the total impulse for object **P** with that of object **Q**. Write down only GREATER THAN, LESS THAN or EQUAL TO. (1)

6.3 Calculate the final velocity of object **Q**. (4)

0,5 m•s^{-1} east

[8]

QUESTION 7

7.1 State the principle of conservation of linear momentum in words. (2)

The most common reasons for rear-end collisions are too short a following distance, speeding and failing brakes. The sketch below represents one such collision. Car **A** of mass 1 100 kg, stationary at a traffic light, is hit from behind by Car **B** of mass 1 300 kg, travelling at 20 m·s^{-1}.

Immediately after the collision Car **A** moves forward at 14 m·s^{-1}. Ignore friction.

This is the picture before the collision.

7.2 Calculate the speed of car **B** immediately after the collision. (4)

8,15 m·s^{-1} west

7.3 To improve passenger safety modern cars are designed to crumple partially on impact.

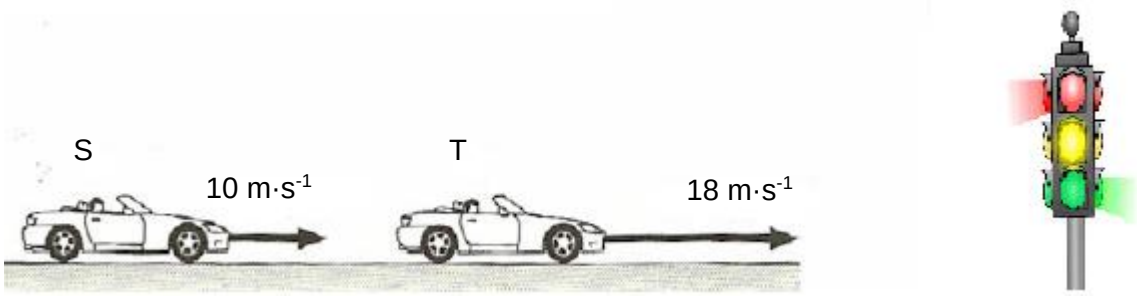
7.3.1 Give a reason why the principle of conservation of linear momentum is still valid during crumpling. (1)

7.3.2 Explain how crumple zones on cars can improve passenger safety. Include a relevant physics equation in your answer. (3)

[10]

QUESTION 8

Two cars S and T travelling on a straight road approach a robot at velocities of 10 m·s^{-1} East and 18 m·s^{-1} East respectively as shown in the sketch. Ignore the effect of friction.



Car T suddenly stops and car S collides with car T. After the collision the two cars move off together as a unit. The combined mass of each car with the driver is 1500 k

8.1 State the law of conservation of linear momentum in words. (2)

8.2 Calculate the speed of the two cars immediately after the collision. (4)

5 m·s^{-1}

Research has shown that forces greater than 85 000 N during collisions may cause fatal Injuries. The collision described above lasts for 0,08 s.

8.3 Determine, by means of calculations, whether the collision above could result in a fatal injury. (4)

The cars have crumple zones, seat belts, air bags and padded interiors that can reduce the chance of death or serious injury during accidents.

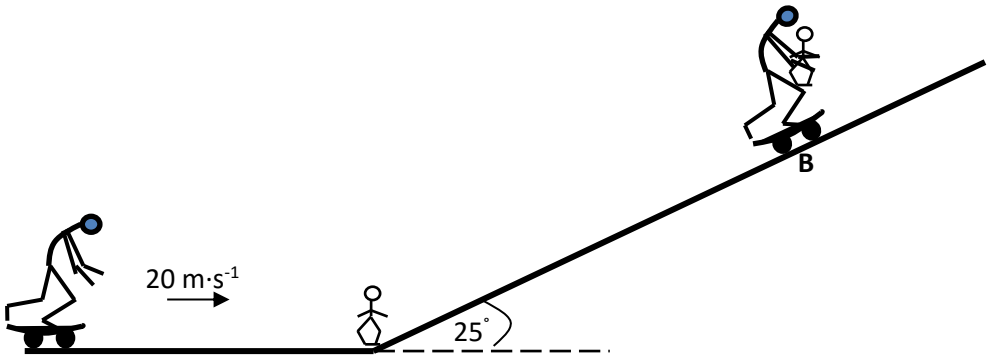
8.4 Use principles of Physics to explain how air bags can reduce the risk of injury or death.

(3)

QUESTION 9

A roller-skater approaches an inclined plane at a constant velocity of 20 m·s^{-1} as shown below. Just before reaching the incline, he picks up a boy standing in his way and then continues up the incline and reaches point **B**.

The total mass of the roller skater is 68 kg and that of the boy is 12 kg.



9.1 State the principle of conservation of linear momentum, in words. (2)

9.2 Calculate the magnitude of the combined velocity of the roller-skater and the boy just after the boy is picked up. (4)

17 m·s^{-1}

9.3 Use energy principles to calculate the distance that they will move up the incline before coming to a stop at point **B**. Ignore the effects of friction. (5)

14,75 m

9.4 How will the answer to QUESTION 9.3 be affected if friction between the wheels of the roller-skate and the surface is NOT ignored? Choose from INCREASES, DECREASES or REMAINS THE SAME. Give a reason for the answer. (2)

[13]

SESSION NO: **2 $ 3**

TOPIC: **ORGANIC MOLECULES**

Organic Chemistry

Intermolecular Forces

Intermolecular forces and interatomic forces (chemical bonds)

- **Name and explain the different intermolecular forces (Van der Waal's forces):**

i. **Dipole-dipole forces:**

Forces between two polar molecules

ii. **Induced dipole forces or London forces:**

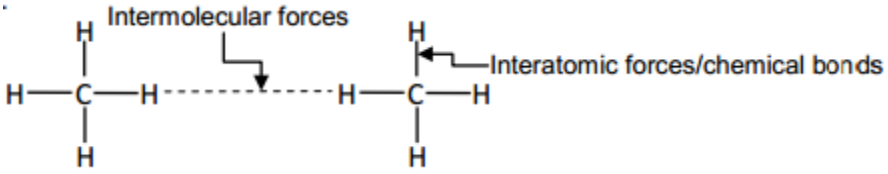
Forces between non-polar molecules

iii. **Hydrogen bonding:**

Forces between molecules in which hydrogen is covalently bonded to nitrogen, oxygen or fluorine – a special case of dipole-dipole forces

- **Describe the difference between intermolecular forces and interatomic forces (intramolecular forces) using a diagram of a group of small molecules; and in words.**

Example:



- **State the relationship between intermolecular forces and molecular size. For non-polar molecules, the strength of induced dipole forces increases with molecular size.**

- **Explain the effect of intermolecular forces on boiling point, melting point and vapour pressure.**

Boiling point:

The temperature at which the vapour pressure of a substance equals atmospheric pressure. The stronger the intermolecular forces, the higher the boiling point.

Melting point:

The temperature at which the solid and liquid phases of a substance are at equilibrium.

The stronger the intermolecular forces, the higher the melting point.

Vapour pressure:

The pressure exerted by a vapour at equilibrium with its liquid in a closed system.

The stronger the intermolecular forces, the lower the vapour pressure.

<u>Organic Molecules</u>

- **Define organic molecules as molecules containing carbon atoms.**

Organic molecular structures – functional groups, saturated and unsaturated structures, isomers

- **Write down condensed structural formulae, structural formulae and molecular formulae (up to 8 carbon atoms, one functional group per molecule) for:**
- **Alkanes (no ring structures)**
- **Alkenes (no ring structures)**
- **Alkynes**
- **Halo-alkanes (primary, secondary and tertiary haloalkanes; no ring structures)**
- **Alcohols (primary, secondary and tertiary alcohols)**
- **Carboxylic acids**
- **Esters**
- **Aldehydes**
- **Ketones**

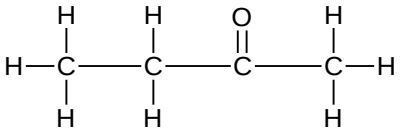
- **Know the following definitions/terms:**

Molecular formula: A chemical formula that indicates the type of atoms and the correct number of each in a molecule.

Example: C_4H_8O

Structural formula: A structural formula of a compound shows which atoms are attached to which within the molecule. Atoms are represented by their chemical symbols and lines are used to represent ALL the bonds that hold the atoms together.

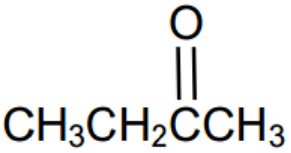
Example:



Condensed structural formula: This notation shows the way in which atoms are bonded together in the molecule, but DOES NOT SHOW ALL bond lines.

Example:

$CH_3CH_2COCH_3$ OR



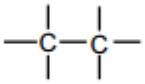
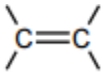
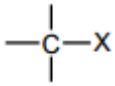
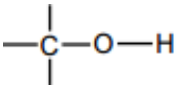
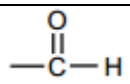
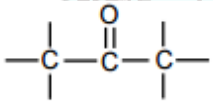
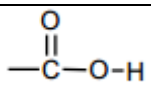
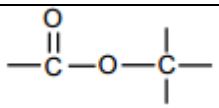
Hydrocarbon: Organic compounds that consist of hydrogen and carbon only.

Homologous series: A series of organic compounds that can be described by the same general formula OR in which one member differs from the next with a CH_2 group.

Saturated compounds: Compounds in which there are no multiple bonds between C atoms in their hydrocarbon chains.

Unsaturated compounds: Compounds with one or more multiple bonds between C atoms in their hydrocarbon chains.

Functional group: A bond or an atom or a group of atoms that determine(s) the physical and chemical properties of a group of organic compounds.

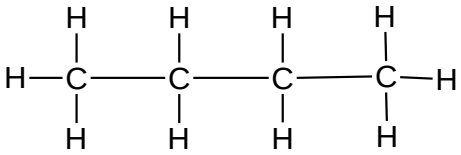
Homologous Series	Structure of functional group	
	Structure	Name / Description
Alkanes		Only C–H and C–C single bonds
Alkenes		Carbon-carbon double bond
Alkynes		Carbon-carbon triple bond
Haloalkanes	 (X = F, Cℓ, Br, I)	Halogen atom bonded to a saturated C atom.
Alcohols		Hydroxyl group bonded to a saturated C atom
Aldehydes		Formyl group
Ketones		Carbonyl group bonded to two C atoms
Carboxylic acids		Carboxyl group
Esters		-

Structural isomer: Organic molecules with the same molecular formula, but different structural formulae

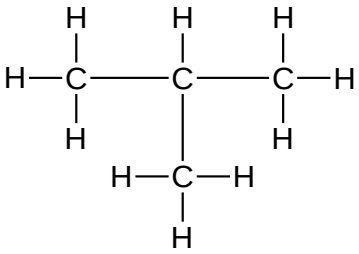
- **Identify compounds (up to 8 carbon atoms) that are saturated, unsaturated and are structural isomers.**

- **Restrict structural isomers to chain isomers, positional isomers and functional isomers.**

- **Chain isomers: Same molecular formula, but different types of chains, e.g. butane and 2-methylpropane.**

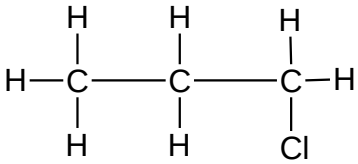


butane

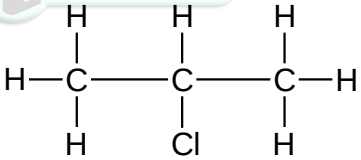


2-methylpropane

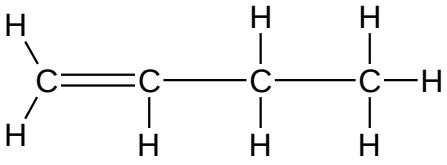
- **Positional isomers: Same molecular formula, but different positions of the side chain, substituents or functional groups on the parent chain, e.g. 1-choropropane and 2-chloropropane or but-2-ene and but-1-ene**



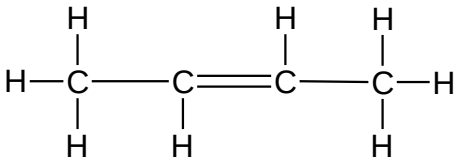
1-chromopropane



2-chromopropane

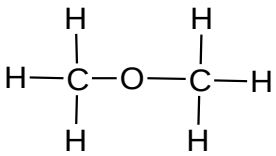


but-1-ene

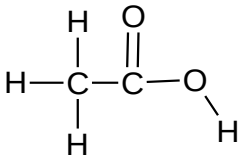


but-2-ene

- **Functional isomers: Same molecular formula, but different functional groups, e.g. methyl methanoate and ethanoic acid**



methyl methanoate



ethanoic acid

IUPAC naming and formulae

- **Write down the IUPAC name when given the structural formula or condensed structural formula for compounds from the homologous series above, restricted to one functional group per compound, except for haloalkanes. For haloalkanes, maximum two functional groups per molecule.**
- **Write down the structural formula when given the IUPAC name for the above homologous series.**
- **Identify alkyl substituents (methyl- and ethyl-) in a chain to a maximum of THREE alkyl substituents on the parent chain.**
- **When naming haloalkanes, the halogen atoms do not get preference over alkyl groups – numbering should start from the end nearest to the first substituent, either the alkyl group or the halogen. In haloalkanes, where e.g. a Br and a Cℓ have the same number when numbered from different ends of chain, Br gets alphabetical preference.**
- **When writing IUPAC names, substituents appear as prefixes written alphabetically (bromo, chloro, ethyl, methyl), ignoring the prefixes di- and tri.**

Structure and physical properties (boiling point, melting point, vapour pressure) relationships

- **For a given example (from the above functional groups), explain the relationship between physical properties and:**
  - **Strength of intermolecular forces (Van der Waal's forces), i.e. hydrogen bonds, dipole-dipole forces, induced dipole forces**
  - **Type of functional groups**
  - **Chain length**
  - **Branched chains**

Oxidation of alkanes

- **State the use of alkanes as fuels.**
- **Write down an equation for the combustion of an alkane in excess oxygen.**

Esterification

- **Write down an equation, using structural formulae, for the formation of an ester.**
- **Name the alcohol and carboxylic acid used and the ester formed.**
- **Write down reaction conditions for esterification.**

Substitution, addition and elimination reactions

- **Identify reactions as elimination, substitution or addition.**
- **Write down, using structural formulae, equations and reaction conditions for the following addition reactions of alkenes:**
  - **Hydrohalogenation:**

The addition of a hydrogen halide to an alkene

  - **Halogenation:**

The reaction of a halogen (Br_2, $C\ell_2$) with a compound

  - **Hydration:**

The addition of water to a compound

  - **Hydrogenation:**

The addition of hydrogen to an alkene

- **Write down, using structural formulae, equations and reaction conditions for the following elimination reactions:**
  - **Dehydrohalogenation of haloalkanes:**

The elimination of hydrogen and a halogen from a haloalkane

  - **Dehydration of alcohols:**

Elimination of water from an alcohol

- **Cracking of alkanes:**

The chemical process in which longer chain hydrocarbon molecules are broken down to shorter more useful molecules.

- **Write down, using structural formulae, equations and reaction conditions for the following substitution reactions:**

- **Hydrolysis of haloalkanes**

Hydrolysis: The reaction of a compound with water

- **Reactions of HX (X = Cℓ, Br) with alcohols to produce haloalkanes**

- **Halogenation of alkanes**

The reaction of a halogen (Br_2, $C\ell_2$) with a compound

- **Distinguish between saturated and unsaturated hydrocarbons using bromine water.**

Plastics and polymers (ONLY BASIC POLYMERISATION as application of organic chemistry)

- **Describe the following terms:**

Macromolecule: A molecule that consists of a large number of atoms

Polymer: A large molecule composed of smaller monomer units covalently bonded to each other in a repeating pattern

Monomer: Small organic molecules that can be covalently bonded to each other in a repeating pattern

Polymerisation: A chemical reaction in which monomer molecules join to form a polymer

- **Distinguish between addition polymerisation and condensation polymerisation:**

Addition polymerisation: A reaction in which small molecules join to form very large molecules by adding on double bonds

Addition polymer: A polymer formed when monomers (usually containing a double bond) combine through an addition reaction

Condensation polymerisation: Molecules of two monomers with different functional groups undergo condensation reactions with the loss of small molecules, usually water.

Condensation polymer: A polymer formed by two monomers with different functional groups that are linked together in a condensation reaction in which a small molecule, usually water, is lost

- **Identify monomers from given addition polymers.**
- **Write down an equation for the polymerisation of ethene to produce polythene.**
- **State the industrial uses of polythene.**

Look at the relationship with regards to

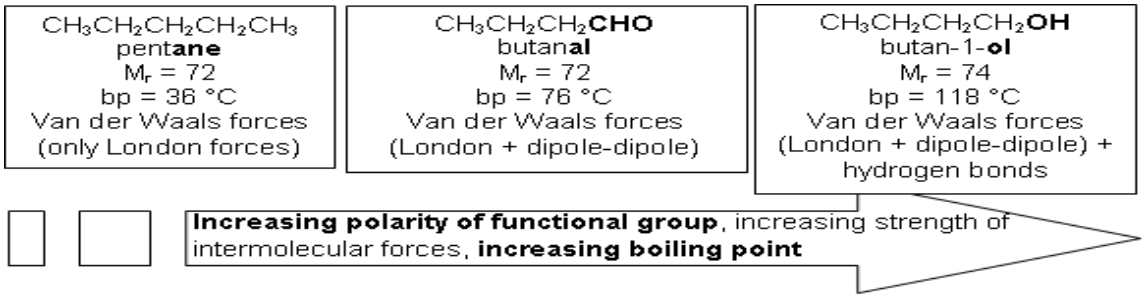
- **Strength of intermolecular force**

London (ALK)	Dipole-dipole	Hydrogen bonds
Alkanes	Aldehydes	Alcohols only one hydrogen bond
Alkenes	Ketones	Carboxyl 2 hydrogen bonds
Alkynes	esters	
	Halo alkanes	

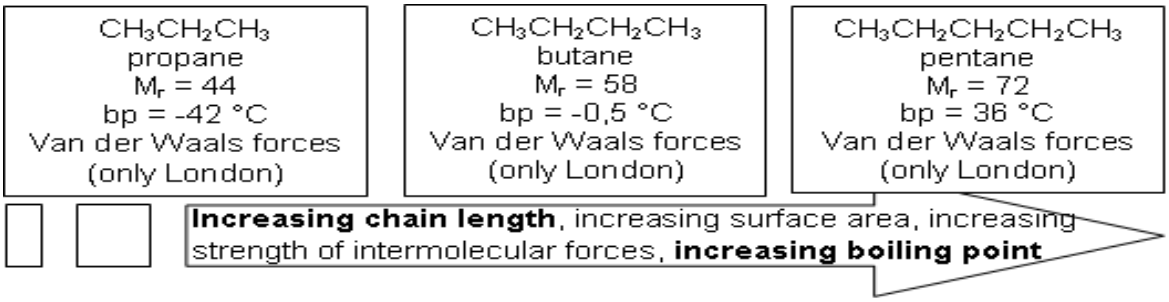
Increasing the strength of the intermolecular forces

Decrease the strength of the intermolecular forces.

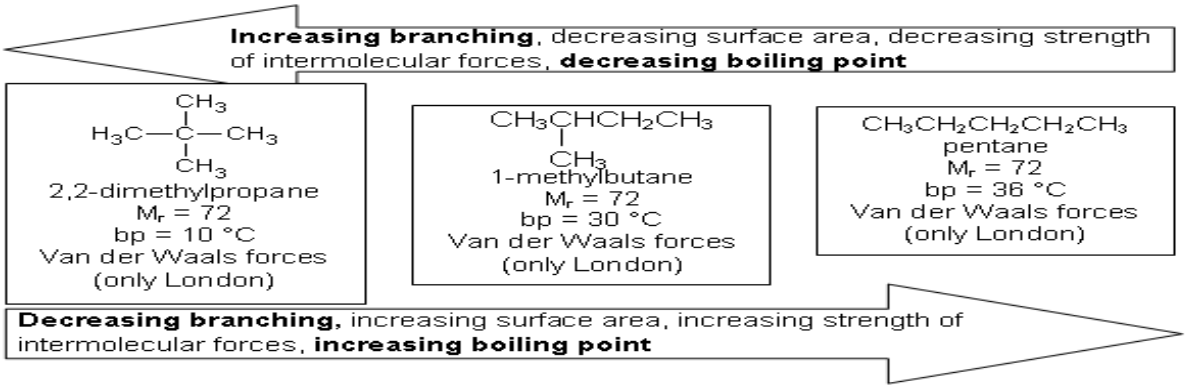
- **Functional group**



- **Chain length**



- **Branched chains**



Esterification- Alcohols and carboxylic acids

Know reactions conditions

Type of reactions	Example	Name of reaction	Condition
Substitution	Alkanes to halo-alkanes		Br_2,Uv light
	Halo- alkanes to alcohols		Conc. NaOH, Reflux
	Alcohols to halo-alkanes		
Addition	alkenes to alkanes	Hydrogenation	
	Alkenes to alcohols	Hydration	Conc. H_2SO_4
	Alkenes to halo-Alkanes	Halogenation	
Elimination	Alcohols to alkenes	Dehydration	
	Halo-alkanes to alkenes	Dehydrohalogenation	

Question 1

1.1.1 Which one of the following compounds has dipole-dipole forces between its molecules?

A. Ethanal
B. Ethane
C. Ethene
D. Ethyne

1.1.2 Which ONE of the following pairs of compounds are FUNCTIONAL isomers?

A. Methanol and methanal
B. Butane and 2-methylpropane
C. Propan-1-ol and propan-2-ol
D. *Propanoic* acid and methyl ethanoate

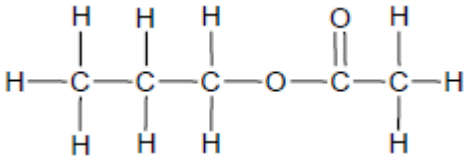
1.1.3 Which ONE of the following is a product formed during the hydrolysis of bromoethane?

A. Water
B. Ethene
C. Ethanol
D. Bromine

1.1.4 Which ONE of the following compounds has the highest boiling point?

A. CH_3CH_3
B. $CH_3CH_2CH_3$
C. $CH_3CH_2CH_2CH_3$
D. $CH_3CH_2CH_2CH_2CH_3$

1.1.5 Consider the structural formula of a compound below.



Which ONE of the following pairs of reactants can be used to prepare this compound in the laboratory?

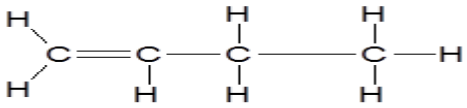
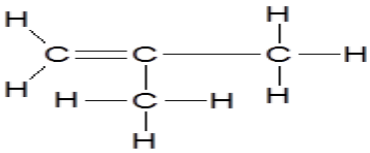
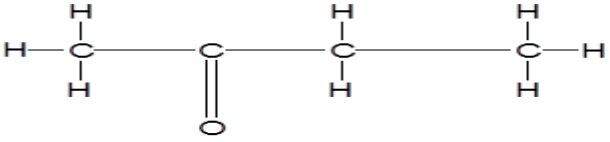
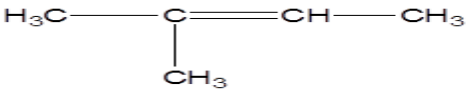
A. Propanoic acid and ethanol
B. Propanoic acid and methanol

C. Ethanoic acid and propan-1-ol

D. Ethanoic acid and propan-2-ol

Question 2

Consider the organic compounds represented by the letters **A** to **G** in the table below:

A 	**B** 
C But-2-ene	**D** $CH_3CH_2CH_2COOH$
E Methyl propanoate	
F 	**G** 

2.1 Define the term **hydrocarbon.** (2)

2.2 Write down the LETTER that represents...

2.2.1 a chain isomer of compound A. (1)

2.2.2 a positional isomer of compound A. (1)

2.2.3 a functional isomer of compound D. (1)

2.3 Define the term **structural isomer**. (2)

2.4 Write down the IUPAC name of compound B. (2)

2.5 Write down the molecular formula of compound C. (1)

2.6 Write down the structural formula of compound **E**. (2)

2.7 Write down the structural formula for the functional group of compound C. (1)

Question 3

A learner conducts a scientific investigation to compare the boiling points of organic compounds belonging to different homologous series. Propan-1-ol, ethanoic acid and propanal are used for the investigation. His results are shown in the table below.

Compound	Boiling point c
Compound A	48
Compound B	97
Compound C	118

3.1 For this investigation, name the …

3.1.1 independent variable. (1)

3.1.2 dependent variable. (1)

3.2 Will the vapour pressure of propanal be LOWER or HIGHER than the vapour pressure of propan-1-ol? Explain your answer by referring to the type of INTERMOLECULAR FORCES present and ENERGY. (4)

3.3 Identify:

3.3.1 Compound A (1)

3.3.2 Compound B (1)

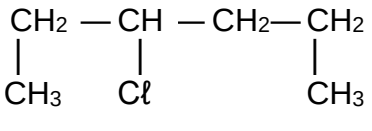
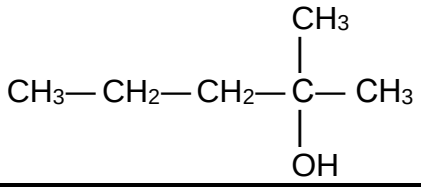
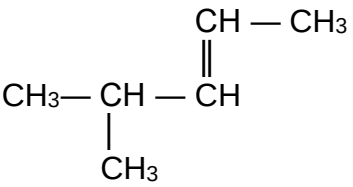
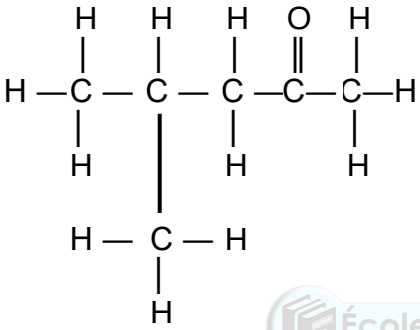
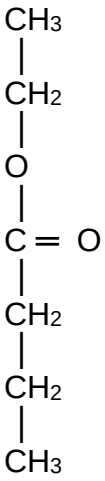
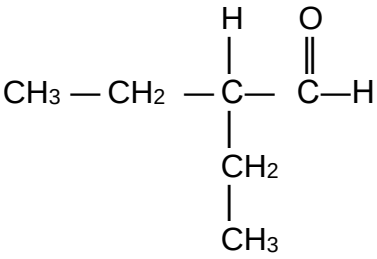
3.3.3 Compound C (1)

3.4 Will the boiling point of butan-1-ol be HIGHER or LOWER than the boiling point of propan-1-ol? Explain the answer referring to the INTERMOLECULAR FORCES. (2)

[11]

Question 4

The letters **A** to **H** represent eight organic compounds.

A		B	
C		D	4-methylpentanoic acid
E		F	
G	Pentan-2-ol		
H			

4.1 Write down the letter(s) that represent(s) each of the following:
(A compound may be used more than once.)

4.1.1 An aldehyde (1)

4.1.2 A compound containing the carbonyl group as a functional group (1)

4.1.3 A tertiary alcohol (1)

4.2 Write down:

4.2.1 the IUPAC name of compound **A** (2)

4.2.2 the NAME of the functional group of compound **C** (1)

4.2.3 the STRUCTURAL FORMULA of the substituent (side chain) of compound **D** (2)

4.2.4 ONE use of compound **F** (1)

4.2.5 the STRUCTURAL FORMULA of compound **D** (2)

Question 5

Three hydrocarbons (A, B and C) with a molecular formula C_5H_{12} are used to investigate the effect of **branched chains** on the **boiling point** of hydrocarbons. The results obtained are given in the table below.

HYDROCARBON	BOILING POINT (°C)
A	36
B	28
C	10

5.1 Are these hydrocarbons saturated or unsaturated? Explain the answer. (2)

5.2 ONE of the hydrocarbons (**A, B** or **C**) has an unbranched chain.

5.2.1 Write down the letter (**A, B** or **C**) that represents this hydrocarbon. (2)

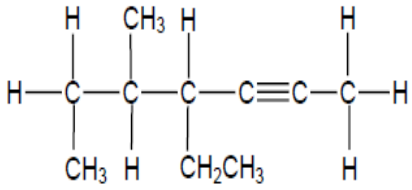
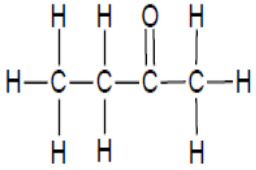
5.2.2 Give a reason why the above-mentioned compounds are considered to be **chain isomers.** (1)

5.3 Explain why hydrocarbon **C** has the lowest boiling point. In the explanation refer to the MOLECULAR STRUCTURE of compound **C**, INTERMOLECULAR FORCES and the ENERGY required. (3)

[8]

Question 6

The letters A to D in the table below represent four organic compounds.

A		**B**	
C	CH_3CH_2CHO	**D**	Butane

Use the information in the table to answer the questions that follow.

6.1 Write down the:

6.1.1 Letter that represents a ketone (1)

6.1.2 Structural formula of the functional group of compound C (1)

6.1.3 General formula of the homologous series to which compound A belongs (1)

6.1.4 IUPAC name of compound A (3)

6.1.5 IUPAC name of compound B (2)

6.2 Compound D is a gas used in cigarette lighters.

6.2.1 To which homologous series does compound D belong? (1)

6.2.2 Write down the STRUCTURAL FORMULA and IUPAC NAME of a structural isomer of compound D. (4)

6.2.3 Is the isomer in QUESTION 5.2.2 a CHAIN, POSITIONAL or FUNCTIONAL isomer? (1)

6.3 Compound D reacts with bromine (Br_2) to form 2-bromobutane.

Write down the name of the:

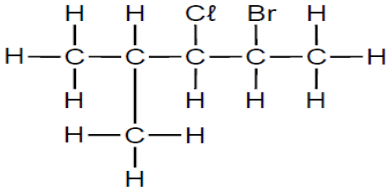
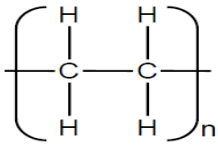
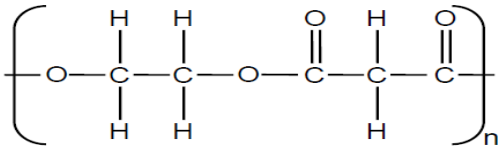
6.3.1 Homologous series to which 2-bromobutane belongs (1)

6.3.2 Type of reaction that takes place (1)

[16]

QUESTION 7

7.1 Consider the organic compounds represented by the letters **A** to **F** in the table below.

A	2,2,4-trimethylhexane	**B**	$CH_3CH_2CH_2CH_2CHO$
C		**D**	
E		**F**	Pentan-2-one

Write down the LETTER that represents the following:

7.1.1 An aldehyde (1)

7.1.2 A condensation polymer (1)

7.1.3 A compound which has a carbonyl group bonded to two carbon atoms as its functional group (1)

7.2 Write down the IUPAC name of:

7.2.1 Compound C (3)

7.2.2 The monomer of compound D (1)

7.3 Write down the structural formula of:

7.3.1 Compound A (2)

7.3.2 Compound F (2)

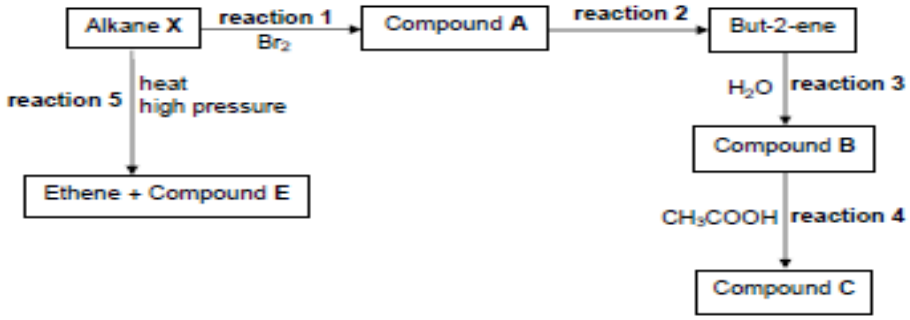
7.4 The table contains compounds which are functional isomers.

7.4.1 Define the term functional isomer. (2)

7.4.2 Write down the LETTERS that represent two compounds that are functional isomers. (1)

Question 8

The flow diagram below shows the conversion of alkane **X** to different compounds.



8.1 For **reaction 1**, write down:

8.1.1 ONE reaction condition (1)

8.1.2 The IUPAC name of compound **A** (2)

8.2 Consider **reaction 2**. Write down the:

8.2.1 Type of reaction that takes place (1)

8.2.2 Structural formula of the chain isomer of but-2-ene (2)

8.3 Compound **B** is the product of **reaction 3**.

8.3.1 Is compound **B** a PRIMARY, SECONDARY or TERTIARY alcohol? Give a reason for the answer. (2)

8.3.2 Write down the structural formula of compound **B**. (2)

8.4 During **reaction 4**, a mass of 7,4 g of compound **B** reacts with 3 g ethanoic acid.

8.4.1 Write down the homologous series to which compound **C** belongs. (1)

8.4.2 Write down the NAME or FORMULA of the catalyst needed for this reaction. (2)

8.4.3 It is found that only 2,5 g of compound **C** forms during the reaction.

Calculate the percentage yield of this reaction (6)

8.5 For **reaction 5**, write down the:

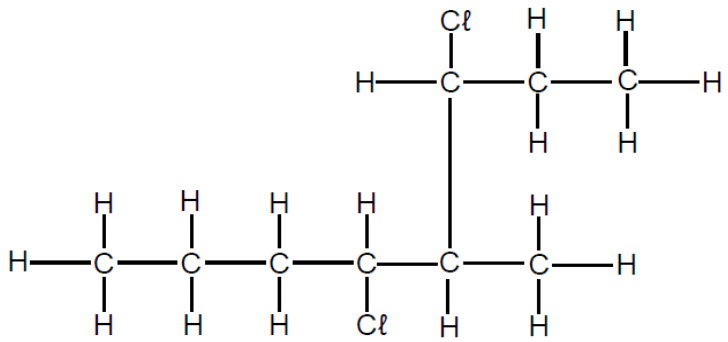
8.5.1 Type of reaction of which it is an example (1)

8.5.2 Balanced equation using structural formulae (3)

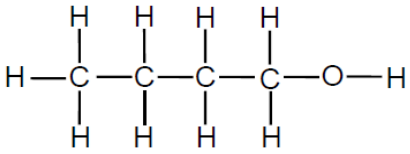
Question 9

9.1 Consider the organic compounds represented by the letters A to C below.

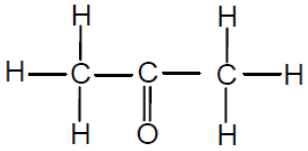
A



B



C



Write down the:

9.1.1 Name of the homologous series to which compound C belongs (1)

9.1.2 IUPAC name of compound A (3)

9.1.3 Structural formula of a tertiary alcohol that is a structural isomer of compound B

9.2 An alcohol and methanoic acid are heated in the presence of concentrated sulphuric acid to form an ester.

9.2.1 What is the role of the concentrated sulphuric acid in this reaction? (1)

9.2.2 Write down the NAME or FORMULA of the inorganic product formed. (1)

The ester contains 6,67% hydrogen (H), 40% carbon (C) and 53,33% oxygen (O). The molar mass of the ester is 60 $g \cdot mol^{-1}$.

Use a calculation to determine its:

9.2.3 Empirical formula (5)

9.2.4 Molecular formula (3)

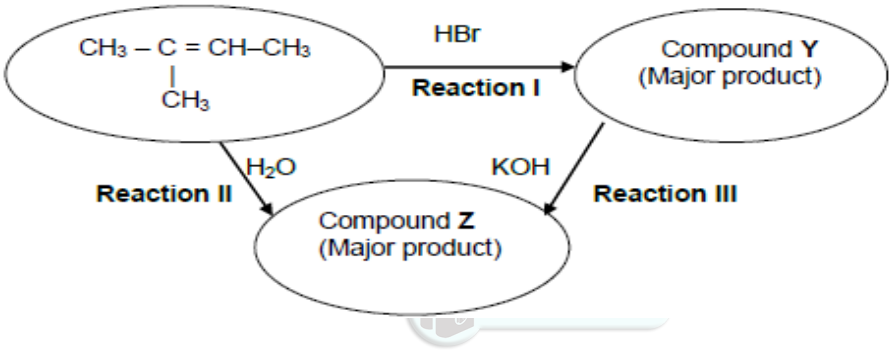
Write down the:

9.2.5 Structural formula of methanoic acid (1)

9.2.6 IUPAC name of the ester. (2)

Question 10

10.1 Petroleum companies use an elimination reaction to break longer hydrocarbons into shorter, more useable hydrocarbons. An example of such a reaction is given: $C_{10}H_{22} \rightarrow C_8H_{18}$ + **X** (in the presence of Heat/catalyst).



10.1.1 Name the TYPE of elimination reaction referred to above. (1)

Molecules of compound **X** can bond to each other to form a polymer.

10.1.2 What is this TYPE of POLYMERISATION called? (1)

10.1.3 Using STRUCTURAL FORMULAE, write down a balanced equation for this polymerisation reaction. (3)

10.2 The flow diagram below shows some organic reactions.

10.2.1 Write down the STRUCTURAL FORMULA of compound **Y** formed in **reaction1**. (2)

10.2.2 Name the TYPE of reaction represented by **reaction I**. (1)

10.2.3 Using STRUCTURAL FORMULAE, write down a balanced equation for **reaction II**. (4)

10.2.4 Write down the IUPAC name of compound **Z**. (2)

10.2.5 Name the TYPE of reaction of which **reaction III** is an example. (1)

10.2.6 List TWO reaction conditions needed for **reaction III** to take place effectively.

uestion 11

11.1 Define the following terms:

11.1.1 Homologous Series (2)

11.1.2 Unsaturated hydrocarbon (4)

11.2 Consider the organic compounds, represented by the letters A to H below:

A	C_3H_7Cl	**B**	$CH_3CHCHCH_3$	**C**	C_3H_8
D	$CH_3CH_2COOCH_3$	**E**	$CH_3CH_2CH(OH)CH_3$	**F**	C_4H_{10}
G	$CH_3CH_2CH_2CH_2COOH$	**H**	$CH_3C(CH_3)CH_2$		

11.2.1 To which homologous series does each of the following belong?

(a) B (1)

(b) G (1)

(c) H (1)

11.2.2 Name the functional group in each of the following:(a) A (1)

(b) E (1)

(c) G (1)

11.2.3 Give the IUPAC names for G and H respectively. (4)

11.2.4 Consider compound D.

(a) Draw the structural formula and give the IUPAC name of each of the two organic compounds from which this substance is made. (4)

(b) Name the type of organic chemical reaction by which this compound is made. 1)

(c) Give two reasons why sulphuric acid is used in the reaction in Question 11.2.4 (2)

11.2.5 The balanced chemical equation for the complete combustion of C is:

$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$

108 g of C_3H_8 initially reacted completely with oxygen.

(a) Determine the number of moles of C_3H_8 that was initially present. (2)

(b) Calculate the volume of $O_2(g)$, at STP, that was used up in the reaction. (3)

(c) Calculate the mass of CO_2 that was formed when 108 g of C_3H_8 reacted completely. (3)

(d) When an additional amount of C_3H_8 was added to the reaction mixture, an extra 67,2 dm^3 of oxygen, at STP, was required to react completely with it. Calculate the additional mass of C_3H_8 that was added. (4)

SESSION 4: VERTICAL PROJECTILE

Vertical Projectile Motion in One Dimension (1D) [EXAMINATION GUIDELINES]

- **Explain what is meant by a *projectile*, i.e. an object upon which the only force acting is the force of gravity.**
- **Use equations of motion to determine the position, velocity and displacement of a projectile at any given time.**
- **Sketch position versus time (x vs. t), velocity versus time (v vs. t) and acceleration versus time (a vs. t) graphs for:**

  - **A free-falling object**
  - **An object thrown vertically upwards**
  - **An object thrown vertically downwards**
  - **Bouncing objects (restricted to balls)**

- **For a given x vs. t, v vs. t or a vs. t graph, determine:**

  - **Position**
  - **Displacement**
  - **Velocity or acceleration at any time t**

- **For a given x vs. t, v vs. t or a vs. t graph, describe the motion of the object: o Bouncing**

  - **Thrown vertically upwards**
  - **Thrown vertically downward**

The following terminologies underpin the TOPIC:

1. Projectile
2. Free Fall
3. Gravitational Force
4. Acceleration due to Gravity.

MULTIPLE CHOICE QUESTIONS

Four options shall always be given as possible answers.

TECHNIQUE IN THE ANSWERING OF MULTIPLE CHOICE QUESTIONS

Step 1: Read the question carefully.

Step 2: Underline the KEY words in the question.

Step 3: Pay attention to words that are CAPITALIZED, or words in ITALICS.

Step 4. Decide whether you are required to recall or use a fact, phenomenon, definition, unit, formula.

Step 5. First, delete the answers that are obviously incorrect (**Called Distractors**)

Step 6. Finally select the correct answer from the others that remain. This is called ELIMINATION and is particularly helpful when the answers or options are very close to each other.

MULTIPLE CHOICE QUESTIONS

1.1 A stone is thrown vertically upwards into the air. Which combination in the table below shows the correct change in the momentum and the potential energy of the stone? (Ignore the effects of air friction)

	Momentum	**Potential energy**
A	Increases	Decreases
B	Decreases	Increases
C	Increases	Increases
D	Decreases	Stays constant

(2)

1.2 A ball is dropped from height **h** above the ground and reaches the ground with kinetic energy **E.** From which height must the ball be dropped to reach the ground with kinetic energy **2E**? (Ignore all effects of friction.)

A 2**h**

B 3**h**

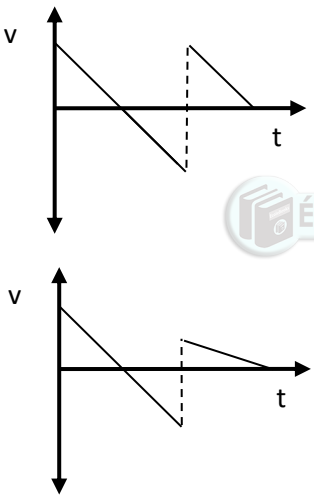
C 4**h**

D 8**h** (2)

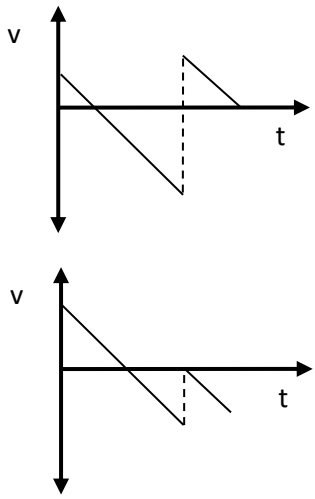
1.3 A ball is projected vertically upwards from the ground. It returns to the ground, makes an elastic collision with the ground and then bounces to a maximum height. Ignore air resistance.

Which ONE of the following velocity-time graphs CORRECTLY describes the motion of the ball?

A



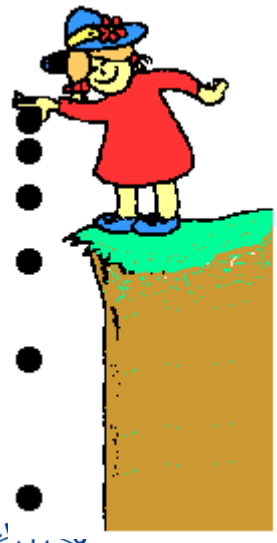
B



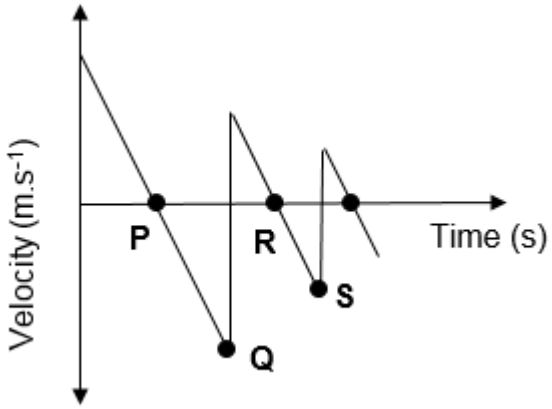
(2)

1.4 A learner drops an object from the top of a cliff. One second later she drops another identical object. While both objects are in free fall, the distance between them

A. decreases
B. remains constant
C. increases
D. at first increases and then decreases. (2)



1.5 A ball is thrown vertically upwards from a certain height above the floor. The ball bounces a few times from the floor. The velocity–time graph below represents the motion of the bouncing ball from the moment it was thrown. Ignore the effects of friction.



Which point (**P**, **Q**, **R** or **S**) on the graph represents the coordinates of the maximum height after the first bounce?

A. P
B. Q
C. R
D. S

(2)

STRUCTURED QUESTIONS

PROBLEM SOLVING STRATEGY

Step 1: Read the statement carefully.

Step 2: Make sense of the statement (Draw a diagram)

Step 3: Take direction (upward as +; downward as – OR vice versa)

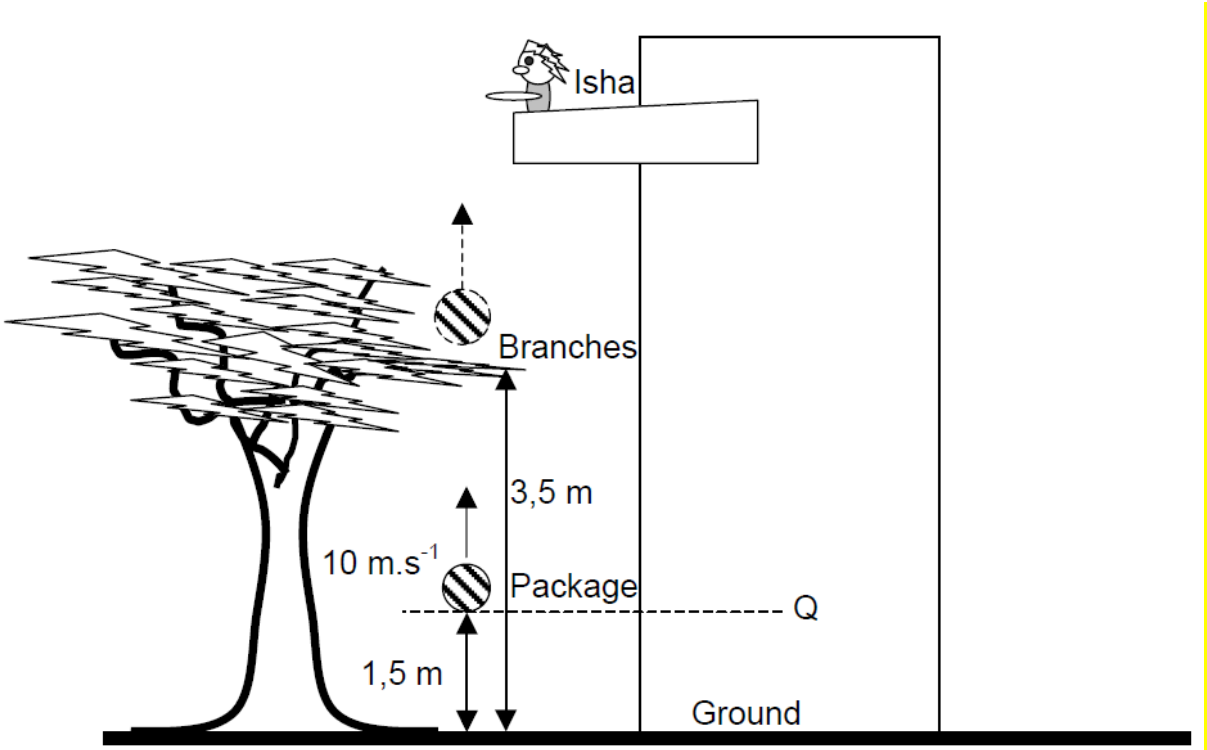
Step 4: Outline the given data.

Step 5: Identify the suitable formula from the DATA SHEET.

Step 6: Substitute the known values into the formula and solve for unknown variable.

QUESTION 1

Akash, standing on the ground, throws a package, mass 500 g, vertically upwards to Isha, who is on the second-floor balcony of a building. At a height of 1,5m above the ground (point Q), the package leaves his hand at a speed of 10 $m.s^{-1}$. At a height of 3,5m above the ground, the package accidentally passes through a thin layer of branches of a tree, but still continues vertically upwards. Ignore the effects of air resistance.



1.1 Calculate the maximum height above point Q that the package could have reached, if the branches had not been in the way. **(5m)** (5)

1.2 State, in words, the Law of Conservation of Mechanical Energy. (3)

1.2.1 Without using the kinematic equations of motion, calculate the speed of the package just as it reaches the branches. **(7,75m.s^{-1})** (7)

The package, on its way upward, leaves the branches at a velocity of 5m•s^{-1} at a height of 3,60m above the ground.

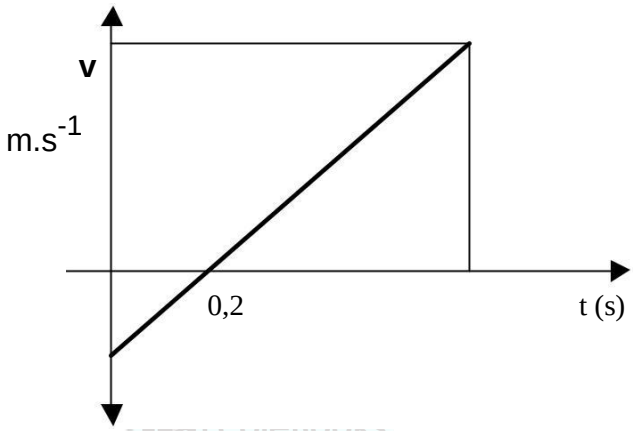
1.3 Calculate the work done by the package in passing through the branches.**(8,77J)** (5)

1.4 Calculate whether Isha, who must catch the package on the balcony at a height of 4,9m above the ground, will be successful. **(4,85m)** (5)

[25]

QUESTION 2

A crane in the East London harbor lifts a crate, mass 300 kg, from the deck of a ship. It then moves the crate horizontally above the surface of the water and stops. The crate is now lifted vertically upwards at a constant speed. When the crate is 30 m above the surface of the water, while it is still moving upwards, the cable holding the crate snaps. The velocity-time graph below represents the motion of the crate from the moment the cable snaps until it hits the water. **Downward motion** is taken as positive and the effects of air resistance can be ignored.



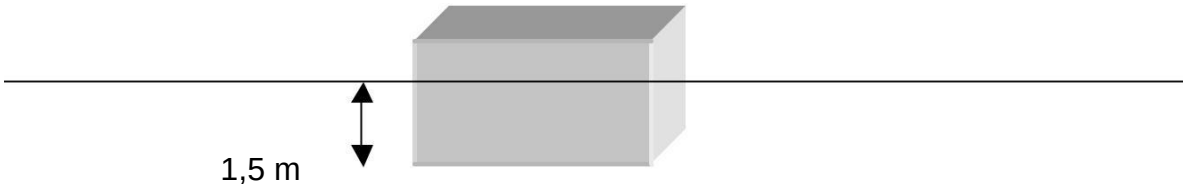
2.1 What does the gradient of this velocity-time graph represent? State also, without doing any calculations, the magnitude of the gradient. (3)

2.2 Determine the constant speed, **v**, with which the crate was being lifted before the cable snapped. (4)

2.3 Determine by using the graph, but **not** any equations of motion, the maximum height which the crate reaches above the position where the cable snapped. (4)

2.4 Show, **without using the time of fall**, that the magnitude of the velocity, **v**, with which the crate strikes the water, after the cable has snapped, is 24,58 $m.s^{-1}$. (3)

The crate, height 2 m, which is completely sealed so that no water can seep in, penetrates (sinks into) the water to a maximum depth of 1,5 m before rising again and coming to a stop.



2.5 Draw a labelled force diagram of the vertical forces acting on the crate when it is at its lowest point (maximum depth). The length of the respective vectors should indicate their relative magnitudes. (3)

2.6 Determine the average acceleration of the crate from the moment it strikes the water until it reaches its maximum depth. (5)

2.7 Calculate the magnitude of the average force that the **water exerts on the crate** to bring it to a stop. (5)

[27]

QUESTION 3

Craig, who's mass is 80 kg, has gone parachuting. He aeroplaned to 10 000 feet (3 km) and jumped. However his parachute is stuck and he starts to panic.

3.1. If his parachute does not open, **use equations of motion** to calculate what velocity he will be travelling when he hits the ground. (Assume no air friction**).** (5)

(245m.s^{-1})

3.2. Find his height above the ground after he has fallen for 5 seconds**.** (7)

(2857m)

[12]

QUESTION 4

A learner investigates the motion of a lift. He places his baby brother of 6 kg on a scale, in a lift. During the first 3 s of the motion, the scale reads 80 N, the scale reads 60 N for the next 5 s and for the last 2 s, it reads 30 N.

4.1 Calculate the magnitude and direction of the resultant force acting on the baby for all three parts of the journey. **(20N, 0N and 30N)** (5)

4.2 Calculate the magnitude and direction of the acceleration for:

4.2.1 the first 3 s and **(3,33 m.s^{-2})**

4.2.2 the last 2 s of the journey, if the lift started from rest. **(5m.s^{-2})** (6)

4.3 Calculate the maximum velocity reached by the lift after the first 3 s of motion. **(10m.s^{-1})** (4)

4.4 Calculate the final velocity reached at the end of the 10 s journey. **(0m.s^{-1})** (4)

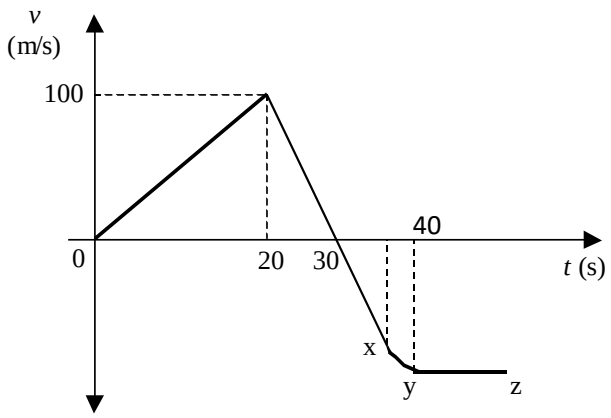
4.5 Using an **appropriate scale**, draw a velocity-time graph for the motion of the baby, for the entire 10s. (5)

[24]

QUESTION 5

The velocity-time graph below represents the motion of a toy rocket which accelerates from rest going vertically upwards away from the earth. After a certain time the engines are switched off.

Study the graph and then answer the questions that follow:



5.1 Using the graph or information from the graph, determine:

5.1.1 the maximum speed achieved by the rocket on its way up. **(100m.s^{-1})** (1)

5.1.2 the magnitude of the acceleration of the rocket during the first 20 seconds of its motion. **(5m.s^{-1})** (3)

5.1.3 the maximum height achieved by the rocket. **(1500m)** (3)

5.2 Explain what has happened to allow for the motion occurring from point **y** to point **z**. (3)

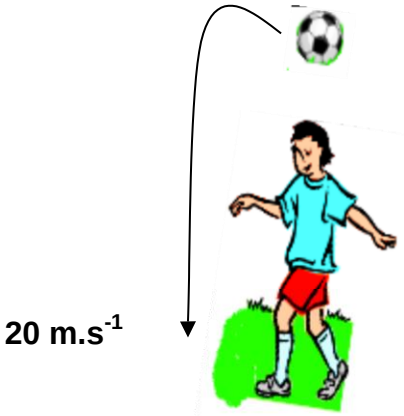
5.3 Draw an acceleration – time SKETCH graph for the motion from t = 20s to t = 40s.

Include all necessary values. (4)

[14]

Question 6

A soccer player juggles a ball on his head by letting the ball bounce continuously on his head. After the last bounce the ball leaves his head it takes the ball 2,4 seconds to reach the ground



6.1 If the ball lands on the ground at 20m.s^{-1} determine the velocity with which the ball leaves the boys head. **(3,52 m.s^{-1})** (5)

6.2 Calculate the maximum height, above the boy's head reached by the ball. **(0,63 m)** (4)

6.3 Sketch a velocity versus time graph representing the balls motion from the moment it leaves the boy's head until it lands on the ground. Indicate all relevant velocity and time values. (3)

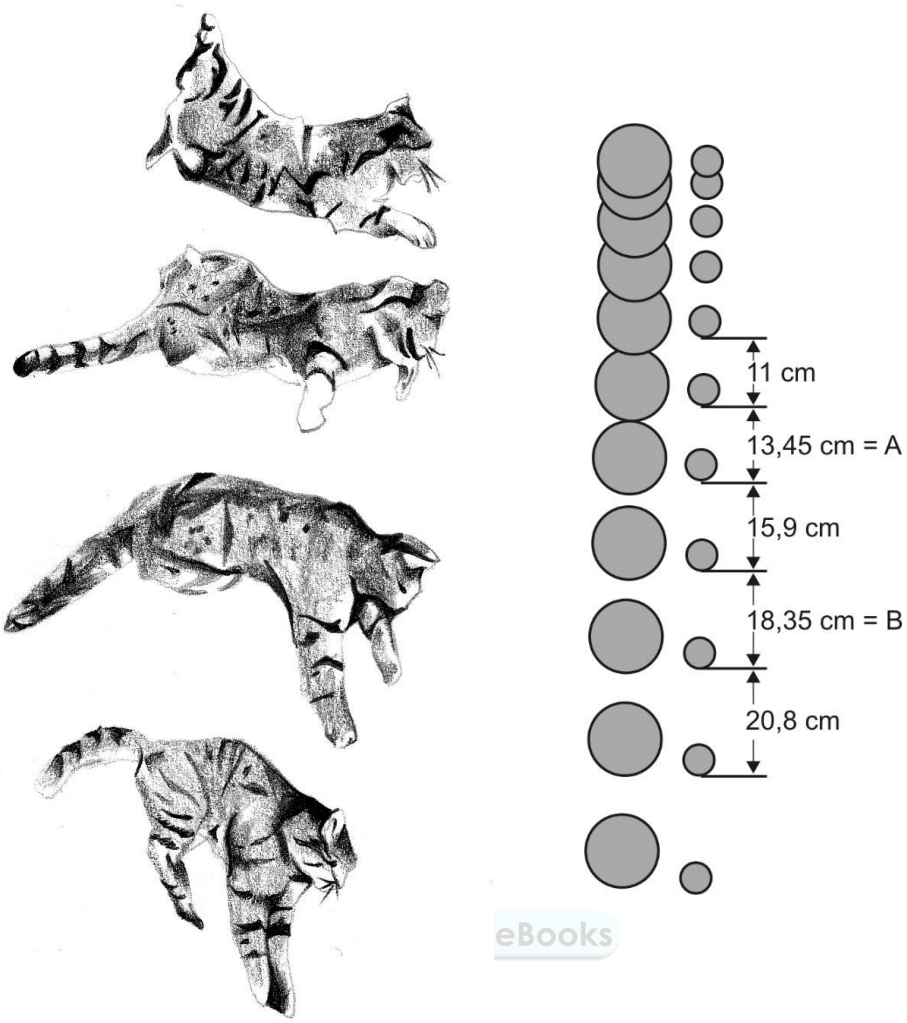
[12]

QUESTION 7

Measuring gravitational acceleration using multi-flash photography

Multi-flash photography is one of several methods that can be used to measure ***g***. A photograph is taken of an object, falling freely in a darkened room. The object is illuminated at a certain frequency, resulting in different images of the same object at different positions during the fall. A multi-flash photograph of a falling cat is illustrated below.

One of the multi-flash photographs illustrated below, shows a small compact ball and a bigger styrofoam ball falling. The balls were illuminated at a **frequency** of **20 Hz**. Using the relationship between frequency and period, the time elapsed between two images can be calculated as **0,05s**. The distances between a few successive images of the small ball were measured and are indicated (**not to scale**) on the photo.



7.1 Looking at the multi-flash photograph above, what evidence do we have that both the small compact ball and the bigger styrofoam ball accelerated? (1)

7.2 Both balls are expected to have the same acceleration due to gravity. Supply a possible explanation for the difference in acceleration of the two balls. (1)

7.3 Prove, using an appropriate calculation, that the time elapsed between two successive images during the fall, is 0,05s. **(0,05s)** (1)

7.4 Use the measurements (not according to scale) indicated on the photo and do the following calculations:

(a) Calculate the average velocity of the ball for Interval A. **(2, 69m.$^{-1}$)** (2)

(b) Calculate the average velocity of the ball for Interval B. **(3, 67m.s^{-1})** (2)

(c) Use the calculated values for the average velocities in (a) and (b) and calculate the acceleration of the small compact ball. **(9,8 m.s^{-2})** (3)

7.5 Draw an acceleration-time graph to represent the motion of the compact ball. (2)

QUESTION 8

A hot-air balloon is rising upwards at a constant velocity of 5 $m.s^{-1}$. When the balloon is 100 m above the ground, a sandbag is dropped from it (see FIGURE 1). FIGURE 2 shows the path of the sandbag as it falls to the ground. Ignore air resistance.

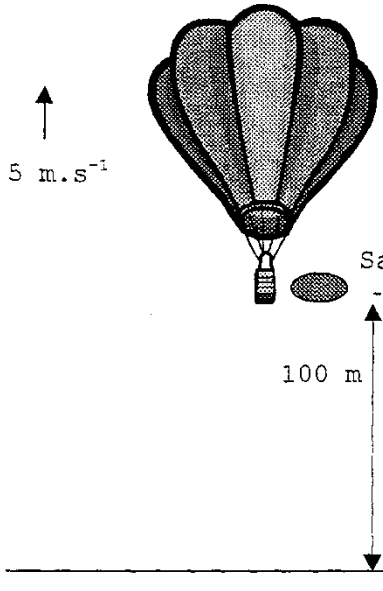


FIGURE 1

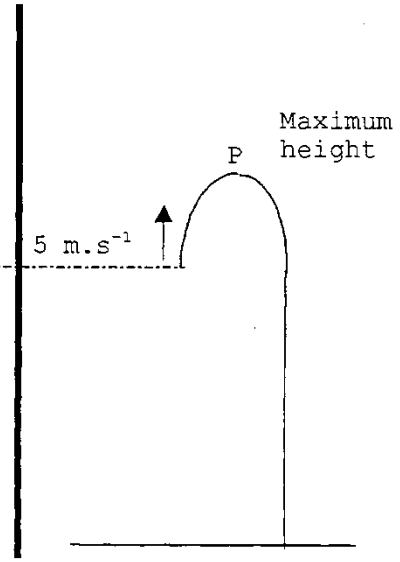


FIGURE 2 Motion of sandbag

8.1 What is the magnitude of the acceleration of:

8.1.1 The hot-air balloon while the sandbag is in it? (2)

8.1.2 The sandbag the moment it is dropped from the hot-air balloon? (2)

8.2 Will the velocity of the hot-air balloon **INCREASE, DECREASE or REMAIN THE SAME** immediately after the sandbag has been released? Explain fully. (4)

8.3 Determine the maximum height P, above the ground, reached by the sandbag after it is released from the hot-air balloon. (4)

8.4 Calculate the time taken for the sandbag to reach this maximum height after it has been released. (4)

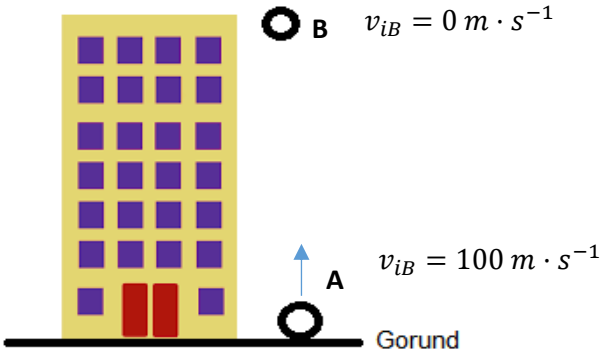
8.5 Calculate the total time taken for the sandbag to reach the ground after it has been released. (4)

8.6 Sketch a neat displacement versus time graph for the sandbag's motion from the moment it is dropped from the hot-air balloon until it hits the ground. Label all available numerical displacement and time values. (5)

[25]

Question 9

A very small rocket **A** is launched vertically upwards with an initial velocity of 100 m.s^{-1}. At the same time a second stone **B** that is initially 150 m high is dropped from the top of very height building. Ignore air resistance.



9.1 Calculate the velocity of stone **B** when it hits the ground.

9.2 Calculate the time taken for **A** and **B** to pass each other.

9.3 Calculate the fly time of the small rocket **A**.

9.4 Draw the velocity versus time graph for the motion of the small rocket **A** from the moment it is launched until it strikes the ground. Indicate the respective values of the intercepts on your velocity-time graph.